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Achieving Energy Security in the Caribbean Basin

by

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Abstract

Concerns over the soaring costs, limited supply and harmful ecological effects of fossil fuels have increasingly caused nations to seek renewable and clean energy. As a result, the bioenergy industry has rapidly matured and become a key component of national energy strategies, particularly for nations dependent on foreign energy. Sugarcane, a native biofuel feedstock in the Caribbean, has tremendous potential for providing such energy security to the region. To evaluate the validity of this notion, an analysis of the global conditions causing the demand for biofuels, the domestic criteria that enable industrial growth, and proven business practices that may rejuvenate the struggling sugar industry is used to determine if Barbados, Haiti, Jamaica and the Dominican Republic can realistically achieve energy security. The outcome of this analysis confirms that great potential exists in the region, but substantial intervention from foreign private and public entities is necessary for long-term success.

INTRODUCTION

The Energy Information Association (EIA) projects that world energy consumption will increase by 50% from 2005 through 2030, and that the global transportation sector's energy requirement will increase by 55% during the same period.[1] Population growth, industrialization, urbanization and economic growth all contribute to the growing consumption of energy.[2] Fossil fuels, which currently supply 86% of the world's energy, are a finite resource and are becoming more difficult and expensive to reach.[3] Complicating matters, politically vulnerable nations produce the vast majority of the world's petroleum, leaving their export capabilities and market value difficult to predict. Moreover, increasing environmental concerns are forcing governments to contemplate global climate changes and urban pollution when they choose their sources of energy. As a result, many industrialized nations are developing sustainable, clean, alternative sources of energy to reduce their reliance on foreign oil and ultimately bridge the energy gap to future renewable technologies.

The transportation sector only has one available alternative source of energy proven on a commercial scale: bioenergy. As the most viable long-term replacement for fossil fuels, bioenergy markets are rapidly expanding. Several ambitious nations are eager to increase the percentage of renewable fuels in their portfolio, particularly with biofuels that can be produced domestically. Ethanol, in particular, has gained popularity as an alternative source of energy because it is renewable, mitigates environmental risks, is a derivative of many crops, and creates social development in rural areas. Brazil's strategic integration of sugarcane ethanol into its domestic energy infrastructure validates these potential gains and further imposes expectations on regional neighbors who traditionally grow sugar crops.

Combined with ethanol's growing demand, high oil prices and the diminishing value of sugar provides the framework and impetus for sugar-producing nations to explore the value-added benefits of diversifying from the traditional uses of sugar. Barbados, Haiti, Jamaica and the Dominican Republic are four Caribbean countries that historically produce massive quantities of sugar, and provide a diverse sample of states within the region that may benefit from domestic ethanol production. The United States, European Union, and Brazil have continually encouraged the growth of biofuel industries in these countries through various trade incentives and substantial investment, but little progress has resulted. A thorough analysis of each nation helps to explain the slow growth of indigenous bioenergy industries, and further validates the continued interest in the region and the potential of Caribbean energy independence.

To help understand the Caribbean's potential for producing biofuels, however, one must not only understand the global conditions that dictate growth of the biofuel industry, but also evaluate specific criteria that enable the industrial growth of ethanol within each country. Accordingly, geography, domestic stability, national will, internal energy demands, existing industry, and foreign investment each help to identify and validate a country's ability to produce ethanol. Yet the global impetus and contextual ability to produce ethanol may not be enough to compel change and keep the sugar industries productive and functioning. An additional analysis of several available business options will ultimately help to determine the survivability of sugar industries and the likelihood of diversifying to support the ethanol industry. In summation, the analysis of the conditions, criteria, and business practices indicate that the high expectations for Caribbean energy security must be tempered in the near term. Short-term gains can be made, but not without foreign aid and technological assistance.

BIOENERGY

The promise of bioenergy extends beyond meeting the growing appetite for renewable liquid energy. In particular, environmental, social and economic advantages contribute to emotional discussions that inflate expectations and entice its investment. To better understand the realistic implications of bioenergy production, it is first necessary to define what bioenergy is, understand how it is produced, and discuss what domestic advantages it is likely to provide.

Bioenergy, or more specifically the material derived from photosynthetic organisms, can be classified into three main categories: i) traditional biomass burned directly for cooking or providing heat; ii) modern biomass-based technologies for the generation of electricity; and iii) liquid biofuels such as ethanol and biodiesel, mainly used in the transportation sector.[4] Biofuels are fuels derived from recently living biological material, whereas fossil fuels come from biological material that has been dead for a long time.[5] Biofuels are classified as either bioethanol or biodiesels. Ethanol is the liquid biofuel that results from the fermentation of sugar crops, or from the hydrolysis of starch or cellulose. Biodiesel results from transesterification, or separation of the glycerin from vegetable oils, or direct extraction from microalgae.

Bioenergy is currently the only alternative source of liquid transportation fuels.[6] Its production provides a clean, renewable alternative to imported petroleum. First generation bioenergy production currently dominates the biofuel industry. Second and third generation improvements to ethanol, such as cellulosic or improved algae extraction methods, offer substantial benefits but will not be discussed at length because they are currently unproven or prohibitively expensive.

Sugarcane is particularly valuable as a bioenergy because of its large physical stature and composition. On a worldwide basis, 69% of each plant is millable stalks, 21% immature cane

tops and leaves, and 10% leafy trash.[7] Mature stalks consist of approximately 13% sugar, 12% fiber and 75% water.[8] When the sugarcane is milled, the fibrous residue, or bagasse, is repeatedly washed and cleaned. Otherwise considered a waste product, the bagasse can act as the primary fuel source in the mills' boilers to generate a self-sufficient and clean source of bioenergy. This technique is called cogeneration. All coal-burning boilers can use bagasse as a supplementary energy source, or existing boilers can be upgraded with little modification to only burn bagasse.[9] An extra benefit for large power plants is the ability to sell surplus energy to local utilities.

As a first generation product, biofuels from sugarcane has the largest energy balance of any other crop, and one that is nearly eight times greater than the energy contained from corn ethanol.[10] (see attachment 3) Even after accounting for the energy consumed in transporting ethanol, such as the cost of exporting ethanol to other countries, sugarcane ethanol still has a total positive net energy balance of 5.6-1.[11] Ethanol also burns more cleanly and completely than gasoline produced from petroleum, and has a lower carbon footprint than traditional fossil fuels.

One of the primary benefits of ethanol is the reduction of greenhouse gas emissions during consumption when compared to traditional fossil fuels. Used in industrial, commercial and residential sectors, the sugar/ethanol energy balance avoids total carbon dioxide emissions by as much as 13%, and further reduces all carbon emissions by over 17% when sugarcane producers use the fibrous cane residue, or bagasse, and stalks for cogeneration in the mills.[12] A 2006 study of lignocellulosic ethanol from sugar stalks showed reduced greenhouse gas emissions by 88%, and a 2008 study reported 94% reduction in greenhouse gas emissions from switchgrass-based ethanol.[13] Greenhouse gases may be reduced in flex-fuel vehicles by as much as 86% for E85 made from cellulosic material.[14]

Sugarcane crops have several other environmental advantages. In tropical regions, water irrigation may be unnecessary because crops have historically grown on rainfall alone. Furthermore, the water consumption required for ethanol conversion and industrial use is low due to efficiency and recycling standards; reuse levels are now more than 98% in Brazilian mills.[15] Additionally, genetic improvements have increased crop yield without excessive land expansion, and adapted sugarcane varieties now thrive in soils of average fertility and require fewer agrochemicals than other crops. Sugarcane crops also reduce soil erosion, and have realized increasing crop yields from the same Caribbean soils for over two centuries. Lastly, all biofuel crops have the potential to sequester carbon, restore degraded soils, and re-establish dominant native crops that enable the prudent management of the Caribbean ecosystem.

The socioeconomics of a viable ethanol industry is also important. In Brazil, where sugarcane ethanol has been produced for over three decades, the agriculture industry spawned a vast workforce of employees and wide range of supporting industries. For every million tons of sugarcane processed in Brazil, 2,200 native Brazilians gain direct employment, and an additional 660 jobs are created to indirectly support the local agriculture industry.[16] Furthermore, the investment needed for job creation is nearly twenty times less than in other industries, and the rate of jobs per unit of energy produced is 152 times higher than in the oil industry.[17] Lastly, untold peripheral benefits exist, such as the creation of schools, daycares, hospitals and restaurants.

Another type of biofuels is biodiesel. It can be blended with diesel or used by itself in diesel engines. Potential biodiesel feedstocks include algae, rapeseed, canola, soy, palm oil, jatropha, used cooking oil, and various other vegetable seeds or oils.[18] Biodiesels offer many of the same advantages as biofuels, but its energy ratio is currently in question by the scientific

community. A study performed by the U.S. Department of Energy, however, did conclude that biodiesel does have a positive energy balance of 3.24 BTUs.[19]

GLOBAL CONDITIONS

American Influences

The United States possesses 2% of the world's oil reserves, but consumes 25% of the world's oil production. America's transportation sector consumes over 65% its oil. To alleviate its foreign energy dependence, comply with clean air legislation, and meet energy efficiency standards, the U.S. has developed a mature ethanol industry and is now the largest ethanol producer in the world. Its capacity to produce fuel ethanol grew from 1.9 billion to 6.1 billion gallons from 2001 to 2007 alone. Government legislation and tax credits accelerated growth so fast that a mature ethanol industrial complex now exists in America. Ethanol produced from corn currently uses over one third of America's corn harvest, and is projected to demand over 43% of is crop by 2016.[20] Despite incredible growth, waning tax credits and domestic fuel demands are causing concerns over corn consumption and America's independent capability to meet legislative goals.

In 2005, the U.S. created the Renewable Fuel Standard (RFS) program to regulate the volume of renewable fuels consumed in the United States. President George W. Bush further refined the RFS with the Energy Independence and Security Act of 2007 (EISA), which now stipulates that America must use 11.1 billion gallons of renewable fuel in 2009 and 36 billion gallons by 2022.[21] Combined with other multinational programs designed to increase the use of biofuels, the U.S. Department of Energy estimates that the global consumption of biofuels will exceed 88.2 and 113.4 million gallons per day by the years 2020 and 2030, respectively.[22] To help stimulate domestic growth, the U.S. offers a Volumetric Ethanol Excise Tax Credit

(VEETC) of 51 cents-per-gallon to domestic fuel providers who blend ethanol with gasoline. Additionally, to protect America's ethanol industry from foreign imports, the government imposes a 54 cents-per-gallon tariff and 2.5 percent ad valorem on imported ethanol.

The United States only provides one loophole for its ethanol tariff. In 1983, the U.S. legislated the Caribbean Basin Initiative (CBI) to stabilize the political and economic climate in the Caribbean region. Accordingly, Caribbean states maintain the duty-free import treatment for ethanol processed in their region, which negates the 54 cents-per-gallon tariff and 2.5 percent ad valorem. Duty-free access to U.S. markets is available for up to seven percent of American ethanol production. Despite this advantage, not a single Caribbean state has reached the maximum import allotments allowed under the CBI. In fact, nearly all of the Caribbean's exported ethanol is Brazilian wet feedstock that is dehydrated in the Caribbean and processed for shipment to the United States. While this conduct does not strictly meet the intent of the CBI, it has encouraged some foreign investment in Caribbean dehydration plants.

European Union Influences

In 2003, the European Union (EU) published its Biofuels Directive to encourage member states to increase the use of biofuels. Accordingly, the directive suggested that biofuels account for 5.75% of all fuel consumption by the year 2010. With the average share of biofuels only at 2% in 2006, the European Commission (EC) formulated its Renewable Energy Road Map, which dictates that member states will increase biofuels usage to 10% of the total fuel consumption by the year 2010.[23] In an assessment conducted by the EC in January 2008, the EC assumes that a full 20% of its biofuels requirements will come from imports to the EU.[24]

In addition to its ethanol mandates, recent EU sugar reforms may prompt sugar industries to transform the vary nature of their industries in a move to stay viable. Of the 12 million metric

tons of raw sugar traded annually, about 4.5 million metric tons reach the United States or the European Union (EU) through preferential trade agreements.[25] Until January 2007, the EU imported up to 1.3 million tons of raw sugar under the African, Caribbean, Pacific (ACP) Sugar Protocol at preferential prices for Least Developed Countries. Reform of the EU sugar protocol, however, will systematically reduce the preferential prices paid to exporters by 36% over a four-year period, which is projected to reduce ACP revenues by 56% over the same period.[26] The void created by the EU's sugar reform will likely entice the ACP countries to seek alternative revenues from their sugar crops because most Caribbean operations are small and expensive compared to other low-cost producers that currently dominate the global sugar market.

The Caribbean region relies heavily on preferential sugar trade. Historically, 100% of Barbadian, over 80% of Dominican, and over 90% of Jamaican sugar exports are bound for the U.S. or EU markets. (see attachment 3) EU sugar reform will clearly confuse future EU demand, as will their policies and demand for ethanol. While the EU will rely heavily on biofuel imports, sugar-based ethanol will likely fill only a small fraction of this demand. Currently, Europe's biodiesel market is considerably bigger than the ethanol market because more than half of Europe's automobiles and trucks have diesel engines.

Regional Overview

Biofuels offer the Caribbean, a region generally void of fossil fuels, with a chance to become a reliable supplier of ethanol to developed markets. Ethanol production could secure a long-term energy supply, mitigate the impact of fuel and oil prices on the domestic economy, and promote environmentally sound energy-consumption patterns for the future.[27] Over the past decade, the worldwide trade of fuel ethanol has grown at a rate of 50% per year, and the most

conservative estimates project continued growth of 10% to 12% annually for the foreseeable future.[28]

The sugarcane industry has flourished in the Caribbean region for the previous five centuries due to favorable climatic and ecological conditions. Adequate rainfall, small temperature changes and long daylight hours contribute to healthy cane growth and sucrose content.[29] Sugar is still an important crop in the region because it accounts for more than 31 percent of the region's cropland and provides jobs to the rural poor.[30] Competition from the global market and alternative sweeteners, however, are eroding sugar's value in the region.

Since 1980, the Caribbean's sugar industry has faltered due to increased competition in the world market. In that time, production costs have declined by about 40 percent in low-cost regions such as Australia, Brazil, South Africa and Thailand, who have increased their global share of exports from 24 to 52 percent.[31] Competition from artificial and starch-based sweeteners has also damaged Caribbean exports. Diversification from sugar to biofuels production, some argue, offers a viable way to reduce dependency on foreign energy and stabilize the Caribbean's export earnings at the same time. Even at maximum forecasted production, the Caribbean is unlikely to meet even a fraction of the world's quantifiable demand for ethanol, which ensures the sustainable and long-term effectiveness of the industry.

One distracter of ethanol production bears mention. Many Caribbean nations, including Jamaica, Haiti and the Dominican Republic, are members of an oil alliance with Venezuela, called Petrocaribe. Accordingly, member states are granted preferential access to Venezuelan oil, which can be financed up to 25 years on 1% interest or traded for food crops. Private industries do not have access to the alliance. Barbados has not agreed to the alliance, most likely for political reasons, including its close affiliation with the U.S.

Petrocaribe may deter member nations from investing in risky and expensive bioenergy excursions, particularly if they are afforded access to less expensive energy from Venezuela. For example, developing nations may be determined to invest their available assets in projects designed to meet the immediate needs of its populace, instead of investing in the potential of bioenergy. Petrocaribe is a short-term solution to a long-term problem.

COUNTRY SUMMARIES

This study examines a diverse group of Caribbean nations. Island size, topography, natural resources, economic conditions, and political stability all vary greatly. On the other hand, cultural ties, regional politics, and common international incentives closely associate each nation with the others, and assumingly binds their expectations. Common regional ties, however, do not provide enough information on how to assess the industrial viability of ethanol. Hence, it is useful to identify explicit criteria that better assess the potential of each country. Specifically, the geography, domestic stability, national will, internal energy demands, existing industry, and amount of foreign investment help determine the productive capacity of Barbados, Haiti, Jamaica and the Dominican Republic. Geography is the most influential of the criteria to be discussed, and requires some discussion before the other criteria and each country is individually addressed.

Just as the physical location of each state is important for its ability to produce sugarcane, the country's size, topographical condition, and capacity to produce food all affect the other criteria used in this study to evaluate ethanol production viability. For example, the use of biomass for energy production relies upon the availability of agricultural resources, and more precisely, land. A surplus of arable land and a capable workforce, for example, provides a greater capacity to produce sugarcane. Small island countries, like Barbados, may have prosperous landowners, but are at a distinct disadvantage because of its geographical limitations.

Conversely, larger countries may have more arable land, but industrial energy requirements or the necessity to grow food affects biomass production. In addition, fluctuating energy trends or global demand may not compel nations to explore alternative or renewable energies because it may already have natural energy resources, such as petroleum, wind or hydroelectric facilities. Therefore, the validity of ethanol production may rely on the size of the country, its population, resources, and the stability of the country.

The Caribbean clearly has distinct advantages for producing sugarcane and potentially maximizing its ethanol producing capabilities, but an underlying trade-off for ethanol is the availability of arable lands for food. Limited agricultural resources and growing populations both provide compelling arguments that there may not be enough land to adequately feed the growing population and cultivate energy crops concurrently. This applies to sugar crops, but also to the future requirements for livestock or other food crops. To produce more sugarcane, farmers must maximize their yield in existing tracts of land, learn to harvest crops in marginal farming land, or decide to import specific food crops. Furthermore, a decision to harvest sugarcane at the expense of traditionally indigenous tropical crops, such as bananas, may have to be made. As urban populations increase, competition for land compounds the requirement to produce enough food to feed the growing population.

The next criteria used to determine the feasibility of ethanol is domestic stability. This simply refers to the political, social and economic security of the state. Stability encourages globalization and inclusion in foreign ventures, and social and economic programs are more likely to be successful and accepted by the population when their basic domestic needs are met. Conversely, instability requires the state to concentrate more acutely on the basic constituency

requirements, such as law enforcement and security, while neglecting programs that superficially help the state.

Assuming the geographic and domestic contexts are suitable for ethanol production, the nation must have the will to invest in biofuels. National will often focuses on short-term economic expenses and gains, but in this scenario should also focus on long-term sustainability and the competitive advantage gained in the energy industry. Three influences particularly shape Caribbean will. First, sugar reform changes the value of sugar exports and may coerce the desire to diversify. American and European subsidies formerly made exported Caribbean sugar and molasses worthwhile because preferential access paid two to three times the world market prices; that is no longer the case. Second, studies show that ethanol production becomes profitable when the price of oil exceeds $30 per barrel.[32] Given the Caribbean's ethanol trade preferences, ethanol production is likely to maintain a higher earnings potential compared to the existing sugar market. Lastly, many industrialized nations are concerned with the environmental effects of fossil fuels, largely because their overwhelming use causes a vast amount of environmental harm. Smaller nations may not have the same concern.

Since all four subject countries import the vast majority of their energy requirements, it is also necessary to define what constitutes internal domestic demand. In this regard, it is useful to measure the desire to use renewable energy in daily operations. The popular will of the nation also contributes to demand, but legislated consumption requirements mostly dictate action.

The U.S., EU and Brazil all heavily finance research and development of ethanol-related products and industries. Whether to bolster existing capabilities or to explore the potential supply chains, their foreign investment is necessary for developing Caribbean countries to capitalize on the potential of biofuels.

Table 1 provides an overview of how each country matches the criteria used to determine the viability of ethanol production. A detailed discussion of each nation follows.

	Geography	Stability	Will	Demand	Industry	Investment
Barbados	X	X				
Haiti						X
Dominican Republic	X	X	X	X	X	X
Jamaica	X	X	X	X	X	X

Table 1

Barbados

Barbados is a low-lying tropical island with a total land area of 166 square miles, of which 37 percent is arable. Barbados maintains a small population of roughly 280,000 people, which is the result of a national family planning program that maintains a growth rate of 0.33%. The island has long been a model for social and political stability, leading to substantial foreign investment and tourism. The Barbadian economy is heavily dependent on external markets, but it is still recognized as one of the most prosperous countries in the western hemisphere.

Barbados has a reserve of about 2.5 million barrels of petroleum, yet it has no refining capabilities and must import over 7,000 barrels of oil per day.[33] Imported petroleum fuels provide nearly 100% of Barbados' consumer electrical and automotive energy requirements. Cogeneration is very important to Barbados, and is now the most important reason to maintain a healthy sugar industry. Barbados plans for renewable energy to account for 40% of the islands electricity by 2010; [34] one third of Barbadian renewable energy will come from sugarcane cogeneration in 2008.[35] This is particular important because Barbadian electricity production is inefficient and expensive.[36] Cogeneration offers both the government and individual entrepreneurs the ability to sell electricity with high profit margins.

Sugarcane accounts for over 80% of Barbados' arable land, yet it accounts for less than 1% of its total Gross Domestic Product (GDP).[37] Contracting sugar prices have decreased export earnings, from $106 million (BDS) in 1980 to $41 million (BDS) in 2003.[38] Barbados traditionally fulfilled sugar quotas to the European Commission (EC), which had the highest subsidies, and neglects deliveries to the U.S. altogether. 2007 EU sugar reforms further decreases the value of Barbadian sugar by 39%, and puts export requirements in question.

Over 1,500 small farms account for Barbados' sugar production. Most farms are on less than 200 acres and hilly terrain, which makes modern mechanization and increased production unlikely due to fiscal and geographical restraints. In addition to inflated pricing from EU and U.S. markets, the territorial framework of Barbados' sugar industry makes it a high cost producer. In 2008, Barbados harvested 31,611 tons of sugar, down 45.4% from the level of production in 2000.[39] Despite decreasing yields, earnings per ton are now 43% higher than in the year 2000, highlighting the importance of exchange-rate movements to the future financial viability of sugar production in the Caribbean.[40]

The relative decline in Barbados' sugar industry has forced the government to restructure its sugar industry to diversify potential gains. Of note, it is transforming traditional sugar growing plantations into recreational facilities, such as golf courses, to capitalize on recreational revenues. The government is also focusing on rural development to rationalize the use of the land and concentrate on the quality of life for its population. Despite these efforts, which in large part results from the high number of private landowners, Barbados has made a conscious effort to stabilize its sugar industry and explore cogeneration. In its 2003 Medium Term Strategic and Macroeconomic Framework, Barbados instituted specific policies to stabilize its sugar industry and seek value-added activities for sugar.[41] (See Attachment 4) Of note,

Barbados is specifically seeking alternative uses for its cane juice, including cogeneration, and will continue to subsidize cane cultivation to meet EU obligations and ensure independent plantations are supported. No specific mention of ethanol is made.

There is no ethanol production in Barbados. A joint proposition to build a $36 million ethanol plant in Barbados was rejected in December 2008. The project's financier speculated that the tourism industry did not want the ocean-side facility to deter its business and thus caused its rejection. [42] The plant would have produced 132 million gallons of ethanol per year, employed 30 full-time residents and provided a 25% stake in local ownership.[43] Given an annual petroleum use of 107 million gallons, Barbados could easily supplement its domestic use and had a surplus to increase its export earnings.

Barbados is politically and economically stable. It has a substantial sugar industry for its size, yet it realizes little economic gain for the state. No biofuel facilities currently exist, nor does any capability seem eminent. Additionally, Barbados has received little financial interest from foreign governments or private ventures for developing bioenergy. Lastly, Barbados maintains a sizeable oil reserve for its small population, and remains focused on the production of electricity through cogeneration.

It is therefore unlikely that Barbados has the will to develop any biofuel capabilities in the near future. Barbados' reliance on the tourism industry and its reserve of petroleum deter national will. Additionally, the requirement for a national electrical grid and affordable electricity dominates the domestic energy discussion. By focusing on cogeneration and subsidizing its sugar industry, though, Barbados at least maintains its ability to diversify in the future. Energy independence is therefore unlikely until the government can provide affordable electricity and broaden its focus to realize the full potential of its sugar crops.

Jamaica

Jamaica is the third largest Caribbean island, with an area of 4,411 square miles. Nearly 16% of Jamaica's territory is arable. It is the fourth most populated Caribbean island, with nearly nine million inhabitants. Jamaica is one of the most energy-dependent countries in the Caribbean Basin, yet it does not have commercially viable fossil fuel reserves. As a result, it imports roughly 72,000 barrels of oil per day. Oil provides over 87% of Jamaica's domestic energy requirements and less than 20% of its transportation requirements.[44] Its bauxite and aluminum industrial sectors are significant energy consumers, and alone use over 36% of Jamaica's available energy.[45]

Jamaica was one of the first Caribbean colonies originally populated for the production of sugarcane. Stagnant production from aging infrastructure and global competition recently caused Jamaica's state-run sugar industry to reconsider its options. Though the industry produced over 108,500 tons of sugarcane in 2007, preferential agreements with the EC have now evaporated. To remain viable in the future, Jamaica is adjusting its domestic ethanol policies and collaborating with Brazil, among others, to provide a strategy for long-term industrial health.

Jamaica's sugar industry employs 40,000 people. Like other Caribbean countries that relied on EU trade preferences, its sugar industry will suffer a 39% decrease in value. Compounding its deflation, Jamaica's sugar industry is globally uncompetitive because its production costs are over three times those of the world's principal sugar exporters.[46] Instead of subsidizing its prices to compete globally, Jamaica is completing an agreement to privatize its sugar industries. The government is currently finalizing the sale of a 75% stake in its sugar mills to a Brazilian company, Infiniti Bio-Energy, which will also lease sugar fields for a minimum of 50 years.[47] In addition to upgrades for cogeneration, both to power its refineries and to sell

excess power to the national power grid, planned upgrades will increase current crop outputs by more than 54%.[48] Similarly, the $200 million takeover will ensure the employment of 13,700 Jamaicans and its ability to meet projected ethanol exports exceeding 26 billion gallons in 2010.[49]

Infiniti represents a strategic victory for Jamaica's sugar industry. Previously, ethanol dehydration by the Sugar Company of Jamaica almost exclusively consisted of imported Brazilian wetstock; the 54% increase in local sugar production is a positive sign. The dehydration business is still booming, however. Jamaica Broilers Ethanol, a subsidiary of the private company Jamaica Broilers Group, is spending an additional $15 million to expand its ethanol production facility to 120 million gallons per year. Combined with the pending ethanol production from Infinity, ethanol will be Jamaica's third largest net earner of foreign exchange.[50] Despite its vast potential to produce ethanol, Jamaica only recently introduced ethanol into its local market.

On 1 November 2008, many Jamaican gas stations offered ethanol blended gasoline to its public for the first time.[51] Jamaica's Minister of Energy plans to displace ten percent of all domestic transportation fuels with Jamaican ethanol. This measure is Jamaica's core diversification strategy to provide some level of energy security by displacing ten percent of its foreign exchange disbursements.

The Jamaica Public Service Company (JPS) has a monopoly on the national electricity grid, however, some private companies are using cogeneration to power their industries on a very limited basis. Jamaica Broilers, for example, produces 5MW of energy, but it is investing approximately $5 million to generate an additional 10MW of energy to sell to the JPS.

In its most recent energy policy, Jamaica aims to reduce its dependence on foreign energy, develop indigenous renewable resources, limit the impact of JPS' energy monopoly, and increase ethanol production. Jamaica has made significant strides in achieving their strategy. Of note, it is improving its own biofuels production capabilities, incorporating ethanol into its domestic consumption strategy, restructuring its sugar sector and attracting foreign investment. Jamaica already refines 3,400 barrels of ethanol equivalent, or 4.6% of its total hydrocarbon imports.[52] The potential gains that will result from foreign investment and its maturing ethanol industry will ensure federal mandates are exceeded in the near future.

The will to expand Jamaica's ethanol industry is apparent. The government of Jamaica will have to postpone true energy independence, however, because foreign shareholders will control a substantial proportion of the bio-industries' wealth. Additionally, Jamaica's continued success hinges on American consumption and support through the CBI, without which energy security would not be possible even in the long-term. Caribbean nations should continue to lobby for its continued existence, or energy security would be a false notion.

Dominican Republic

The Dominican Republic occupies the eastern two-thirds of the island of Hispaniola, an area occupying approximately 18,815 square miles. The population of the Dominican Republic is generally young and exceeds 9.5 million people, with a current growth rate of 1.64% annually. The migration rate currently exceeds 4%; most migrants settle in the United States. Services contributed to over 64% of the Dominican Republic's GDP and employed over 58% of its population.[53] The Dominican Republic does not have any proven oil reserves, and spends $2.5 billion, or 35% of its annual revenues, on fuel imports. Additionally, oil meets 72% of its domestic energy needs, coal fills an additional 8.2% of its domestic energy needs.

Sugar mills continue to be a major source of work for rural Dominicans. Over 65,000 workers, down from 100,000 in the 1980s, are employed by one of three groups that control nearly all of the Dominican sugarcane plantations and industrial plants.: the state-run State Sugar Council, a private family-run operation called Casa Vicini, and a multinational firm called Central Romana. The State Sugar Council accounts for over half of the Dominican Republic's total sugar production. Only twenty years ago, the sugarcane industry accounted for 85% of the Dominican Republic's export revenues, but today sugar constitutes less than 10% of the export revenues.

The Dominican Republic is the only Caribbean nation in this study that relies on the U.S. import quotas. In the last decade, it is the only Caribbean state to meet 100% of the U.S. quota every year. Like other Caribbean nations, however, its sugar industry has suffered due to global competition from low-cost competitors and antiquated equipment; more than half of the Dominican sugar mills were built in the 19th century.[54] Despite recent setbacks, however, the sugar industry has the land and potential for investment to successfully develop an ethanol-producing industry.

The Dominican Republic has 4,232 square miles of arable land, of which 1,351 square miles is devoted to sugar crops.[55] In 2004, it produced 5.55 million metric tons of cane from 525 square miles, which is down from a peak of 11.8 million metric tons of cane cultivated from 903 square miles of land in 1982.[56] In a recent Caribbean seminar on Biofuels, a Dominican representative claimed to have an additional 386 square miles of uncultivated land that could produce additional biofuels. According to one state study, the Dominican Republic could produce 100 million gallons of cane ethanol each year from its current sugar crops, of which 70% would be exported to the United States.[57]

The government has made a strong effort at establishing an environment to enable the production and consumption of biofuels at "an industrial scale."[58] In 2002, the Dominican Republic released a plan to grant incentives to industries interested in developing biofuels industries. Furthermore, it established a two percent consumption tax on fossil fuel and petroleum products to benefit programs promoting alternative, clean, or renewable energy sources and energy efficiency.[59] The fund now contributes a full five percent of tax revenues, or about $25 million every year. In 2005, the Dominican Congress further legislated the *Law of Incentives for the Development of Renewable Energy Sources…* to promote renewable energy production, which would grant generous tax holidays and exemptions for potential biofuels investment.

Some private investment has materialized. In 2002, China invested $250 million to refurbish a sugar mill to produce ethanol. A Belgium consortium, led by Alcogroup, is also building a new sugar mill, with further plans to turn an existing refinery into an ethanol plant.[60] Additionally, a local company called BioEGroup plans to invest $300 million to build two ethanol plants that will produce 35 million gallons of ethanol per year, and cogenerate 30 megawatts of energy from the cane bagasse.[61] Most recently, Brazil is finalizing an agreement to build a $500 million plant. Accordingly, the Vicini operation would produce 100,000 tons of sugar to produce 50 million gallons of ethanol, and 700 megawatts of electricity from the cane bagasse.[62]

Some U.S. territories are beginning to realize the benefits of obtaining Dominican ethanol under the provisions of the CBI. Also, Caribbean biofuels are proximate, inexpensive, and can help to meet federal quotas. Most recently, Puerto Rico is solidifying a strategic alliance with the Dominican Republic that will establish Puerto Rico as a "vast regional platform" to consume and

distribute Dominican ethanol.[63] Puerto Rico could serve as a refinery and as the primary distributor if an agreement is met. Florida is also rumored to be evaluating the benefits of Dominican ethanol. Florida may need as much as 786 million gallons of ethanol in 2010 to meet federal mandates, and U.S. ethanol production is cost prohibitive and in short supply.[64]

Recent transgressions indicate the great potential of biofuels production in the Dominican Republic. Domestic regulation and legal incentives, combined with the petroleum crisis in 2008, provided an environment ripe for foreign investment and increased domestic consumption. Even as the Dominican Republic imports and consumes approximately 4.9 million gallons of petroleum per day, or 1.8 billion gallons per year; there will an excess of production to easily offset ten to twenty percent of its oil imports with native, sugar-based ethanol. The creation of domestic jobs is also important to long-term stability. The Dominican Republic clearly fulfills all the required criteria necessary to sustain long-term viability in the biofuel industry.

Haiti

Haiti occupies the western third of the Island of Hispaniola, and is the poorest nation in the Western Hemisphere. It is the third largest country in the Caribbean, with a total area of 10,714 square miles. Haiti's terrain is mostly mountainous, but it does have small coastal plains and is over 28% arable. Only 80 years ago, Haiti was lush and forests covered 60 percent of the territory. Today, less than two percent of the forests remain, leaving over 97% of the total land area barren.[65] Widespread poverty is the root cause for Haiti's environmental crisis because the majority of Haitians depend on charcoal to heat their food. As a result, rampant deforestation in the quest for fuelwood has instigated massive soil erosion and floods in mountainous regions. Accordingly, its agriculture industry is near defunct and its domestic sugar capabilities are close to extinction.

Agriculture was the mainstay for Haiti's economy until the late 1980s, when it employed 66% of the labor force, accounted for 35 percent of the GDP, and 24% of the exports.[66] In the mid 1970s, Haiti produced about 6 million tons of sugar, but became a net importer of the product starting in 1976.[67] Most of its current sugar imports originate in the Dominican Republic. The Haitian Ministry of Commerce and Industry does not publish information on its agricultural industry, but the Food and Agricultural Organization (FAO) of the United Nations estimates that only 170 square miles of cropland is used to produce sugar. Domestic sugar is primarily cultivated by small-scale farming operations and turned into rum for export.[68]

Haiti must import all of its carbon-based energy requirements, which amounts to nearly 12,000 barrels per day. Haiti relies on diesel fuel to produce 60% of its domestic electricity production and all of its transportation requirements. Thus, Haiti's inherent reliance on diesel fuel may make a biodiesel, not an ethanol, attractive as an alternative energy source. Haiti does not have any biofuels policies, however the FAO is promoting the adoption of a biodiesel program. In addition, the World Bank and Inter-American Development Bank have contributed over $196.6 million in concessionary loans to improve port and road infrastructures.

Haiti's ecological issues, poverty, corruption, lack of public utilities, and aging infrastructure make ethanol production unreliable and unlikely. Given the severity and priority of other domestic issues, it is particularly hard to rationalize environmental concerns. However, Haiti must find a renewable and inexpensive alternative to fuelwood before its natural habitat is destroyed beyond repair. While ethanol is likely not an immediate option for Haiti, a plant called jatropha may be.

Parts of India and some African nations are using the jatropha curcas as a natural biofuel to burn in their stoves or lamps. Jatropha thrives with little water, can grow in varying, even

poor, soil conditions, and will not be eaten by goats or cattle (its leaves and seeds are toxic). Therefore, jatropha can reduce imported fuel requirements, provide a renewable replacement for charcoals, and help eliminate the ecological effects of deforestation. Over 70% of the Haitian island has a "high" erosion risk due to deforestation, which jatropha could likely mitigate as it has in other countries.[69] A 2007 study on watershed preservation commissioned by USAID reinforced this fact, adding that "it was more effective than traditional tree-planting efforts that have been used to help reforest Haiti."[70] Furthermore, jatropha is indigenous to the island and must be harvested by hand. Its production would create countless jobs for an island where more than two-thirds of the population is unemployed. These benefits can be realized in less than one year's time.

Aside from its use in replacing charcoal as a fuel source, biodiesels would also be useful for the transportation and power generation industries, both of which currently rely on diesel oil.[71] In 2007, the Haitian Ministry of Agriculture planted over 12,000 jatropha seedlings in varying landscapes and started to experiment with different planting and cultivating techniques. Sirona Fuels, a California-based company, is also focusing on privately funded jatropha farms in Haiti, which it hopes will expand its effort in bringing jatropha-based biofuels to the U.S. market.[72] Moreover, in 2008 the Haitian government reached an agreement with a green energy service provider, Haytian Tractor and Equipment, who expects to cogenerate enough power to generate electricity for two cities on jatropha alone.[73] Haytian, which will own a 10 percent stake in the venture, said it plans to expand into algae feedstocks for future production.

Algae may one day be the standard in bioenergy, so it bears mention. Microalgae feedstocks have several advantages over first-generation bioenergies. First, they grow very rapidly, and can double their biomass overnight to produce fifteen times more oil per hectare

than alternative sources, including jatropha.[74] Second, algae can grow in cultivation facilities built on land unsuitable for other crops, which benefits natural ecological balances and food crops that would otherwise compete with bio-crops. Third, "up to 50% of an alga's body weight is comprised of oil," and it can be cultivated every day, unlike other biofuel feedstocks.[75] Fourth, biodiesels from algae feedstocks can be used in existing diesel engines, without modification.[76] Lastly, "algae biofuel contains no sulfur, is non-toxic, highly biodegradable and, therefore, is a much cleaner-burning fuel than petroleum-based diesel."[77]

Jatropha provides Haiti with the solution to its short-term inadequacies. Small fiscal gains and improvements in lifestyle are worth their weight in gold for a nation stricken with abundant poverty and unemployment. Jatropha can be grown on small plots of land, and can be effectively used to communally generate heat and electricity for a population that is 70% rural and not on a national power grid. It can eliminate the terrors and consequences of flash floods, and increase safety by providing light at night. Perhaps most importantly, it can generate employment and a spirit of entrepreneurship and hope. Bioenergy must be supported in Haiti, especially by support from its regional neighbors.

ALTERNATIVE SOLUTIONS

To further evaluate the viability of ethanol in each country, it is appropriate to examine the available options Caribbean sugar industries have for generating revenue and combating market erosion. A 2005 study conducted for the World Bank suggests that Caribbean sugar markets could improve their competitiveness through privatization, government intervention, professional management staffs, rationalization, or by value added techniques.[78] The concept of crop diversification also bears mention. Crops can either be diversified to support new products, or diversified out of sugar altogether. Sugar is the key to Caribbean energy security, it is

therefore useful examine which concepts have failed and succeeded to better understand their impact on the ethanol sector.

Diversification

Previous efforts to diversify out of the sugar industry have been largely unsuccessful for Caribbean producers. The World Bank tried to diversify Barbadian sugar into vegetable production in the early 1980s, however the effort failed once the World Bank terminated its support. Due to high tariffs on imported fruits and vegetables, Jamaica has a government-sponsored program to diversify sugar crops into these industries; however, the program is very small and only intended to support the tourism industry. Other problems arise from inappropriate project design, poor technology, improper institutional arrangements and inadequate funding.[79]

Diversification into other industries is also possible. Sugarcane is a raw material for a host of derivatives used in food, chemical, pharmaceutical and biotechnology industries.[80] Additionally, sugar can also be used as a byproduct for use in animal feed, resins, preservatives, plastics and inputs for pulp and paper mills. These options are all viable, especially now that sugar subsides are losing support, but unlikely given the dramatic cost difference compared to what sugar producers are used to earning. Some sugar industries simply do not need to diversify. The rum industry remains stable because bulk ethanol used for rum is twice as valuable as fuel ethanol.

Privatization

Most Caribbean sugar industries are state-owned operations. Jamaica first tried to privatize its five state-owned sugar estates in 1994 because two of its private estates systematically had higher yields, produced more sugar per ton of cane and per hectare, maintained lower labor costs, and had less factory down time.[81] All five Jamaican estates were

returned to public ownership in 1998 because depressed production and high costs caused a near collapse of the industry. Since 1998, the Sugar Company of Jamaica has lost $283 million.

The World Bank remains involved with failing sugar industries, but its help is usually short-lived and only rescues sugar operations from complete collapse. The lack of international support complicates matters because Caribbean factories and refineries are overwhelmingly old and inefficient, and outdated employee benefits and relationships will drive up costs. Recapitalization will be expensive.

One possible solution is the partial privatization of the sugar estates, where the government maintains ownership of the industrial complexes. The government could then subsidize the price of the crops until they become profitable and stable. The other alternative rests with large, multinational corporations who seek to diversify sugar. Companies similar to Brazil's Infiniti Bio-Energy may be the only suitable partner and likely hope for future privatization. Even still, new management will demand high government subsidies and substantial tax incentives to recover failing operations, and will expect a substantial reduction in the cost of ownership to hedge against disappointment.

Management

State-run and private sugar industries may benefit from independent corporate management or oversight. Professional managers can provide technical, managerial, marketing and legal expertise that can guide ownership through the trends in sugar production. Barbados, Haiti, Jamaica and the Dominican Republic all have, or have had, contracts with Booker Tate, a private management company in the United Kingdom.[82] Booker Tate specializes in sugar, ethanol and bioenergy agribusiness projects, and already has contracts with over 120 sugar-producing nations.

The Government of Barbados contracted Booker Tate in 1992 to rehabilitate its arable lands, heavily indebted sugar plantations, three sugar factories, and the sugar terminal. As a result, the Barbados Agriculture Management Company (BAMC) was formed in 1993 to oversee Booker Tate and its operations. Sugar crops have increased each year and Barbados was able to meet all of its former EU quotas. Additionally, the BAMC successfully started using excess bagasse for cogeneration, however, no apparent efforts have been made towards the production of ethanol. Booker Tate's expertise in the biofuels area may prove useful in generating the momentum and support necessary for diversification into this niche.

In 1994, Booker Tate purchased a 17% share in The Sugar Company of Jamaica (SCJ). The government of Jamaica retained a 49% holding. After four years, the government reacquired full ownership of the SCJ because the "private partners failed to provide sufficient capital to keep the sugar factories afloat."[83] In 1998, Jamaica infused new funds into its sugar operations to keep production afloat for the next decade. Clearly, the government's decision to contract an external management company did not work out for Jamaica's sugar industry, but Booker Tate may have had more success if it had more control of its operations.

Government Assistance

Just as new or struggling industries in America receive assistance, the Caribbean sugar industry warrants significant government support. Direct financial assistance through subsidies and tax exemptions are important, but indirect enablers are perhaps more significant because they also stimulate growth in the industries that surround and support the sugarcane industry. For example, by creating or improving roadways critical to transportation of the crops, or by providing access to power, fuels, and communications at competitive rates, private estates could have access to the infrastructures needed to be efficient.[84] It is essential that the host state

nurtures the institutional framework that can guide policies and technologies towards sustainable development and production.

Governments could also foster relationships with nearby states or foreign industries that could benefit from their regional stability. Support may come through technological expertise or technical assistance, through financial breaks and incentives to encourage foreign investment, and by allowing foreign capital to participate in sugar production on a greater scale.

Rationalization

Another less popular option for maximizing the value of a product is to simply downsize production altogether. With a smaller footprint, businesses can focus the efforts of its best resources to maximize its efficiency and effectiveness. This option is particularly useful for an industry that fluctuates, like the sugar industry, where production can be scaled to meet the required output level. This option is obviously more viable for large operations with multiple resources, especially if the company can diversify its products. Either way, rationalization can allow a product to become more competitive by focusing its strengths to maximize production.

In 2002, Cuba reduced its operating sugar mills from 156 to 61 and concurrently reduced the sugarcane crop area by a comparable amount.[85] Similar to the circumstances of its regional neighbors, world market prices and aging equipment forced Cuba's change. As the price of sugar and production levels increased in 2005, Cuba adjusted its crops and production accordingly. In 2008, Cuba's sugar industry produced its first surplus this decade; the country had an extra 400 million tons to ship to China.[86]

Value added solutions

The competitiveness of the sugar industry may lead companies to one of the previous alternatives: diversification, privatization, management changes, government intervention, or

rationalization. The combination of all or some of these options may be the best solution for small Caribbean operations because low-cost sugar producers continue to improve their global competitive advantage over Caribbean sugar. The chosen strategy, though, must consider long-term sustainability and competitiveness. In the short-term, there are additional ways to maximize the value of sugar without actually changing the crop or harvest.

Cogeneration is one proven solution that is inexpensive and offers immediate benefits for Caribbean sugar growers. Many recognize Hawaii as the industry standard for cogeneration, largely because it was the first to become functional in a large-scale operation. Initiated in 1987, its cogeneration facilities have grown to total 13 factories that produce 400MW of energy, or about ten percent of the energy on the national grid.[87] Hawaii's success is gaining attention not only for its ability to use the bagasse efficiently, but also for the environmental benefits of burning a carbon-neutral incendiary. Kauai, the fourth largest island in the Hawaiian archipelago, cogenerates 55% of the islands energy; Kauai is three times larger than Barbados.

In its 2003 Commodity Specific Strategy, Barbados' aimed to "take advantage of value added activities in pharmaceuticals, energy, alcohol, rum, board, wax and sweeteners."[88] Using Hawaii as a template, Barbados specifically initiated its "Fuel Cane" project in 2004 with the intent to harvest a genetic variation of sugar cane for the purpose of cogeneration.[89] The variant, appropriately called fuel cane, is harvested on 68 acres specifically and completely for its ability to generate 30MW of electricity. The program became fully functional after four years.

CONCLUSION

Latin America and the Caribbean Basin have the largest global surplus of croplands, and their biofuel crops could supply between 20-65% of the world's energy demand, or 100% of its transportation needs.[90] However, this potential to produce sustainable energy comes from the

abundant crop fibers of sugar, starch and the oil from plants, which will soon be available with next generation bioenergy techniques. It is therefore necessary to continue producing conventional crops to ensure the agricultural land and its yields are available for future energy technologies. Meanwhile, the international community should continue to finance and support the international trade of food and biomass from energy corps, and provide the technical and agronomic assistance necessary to help the industries thrive.

The U.S., EU and Brazil should also maintain support of international agreements that stimulate the growth of Caribbean sugar and ethanol, independently or otherwise. Privatization, rationalization, government assistance, value added solutions and managerial practices offer little hope and false promises for Caribbean sugar industries. Diversification from sugar crops has also proved to be fruitless and only masks the greater domestic issues at hand. Diversification into energy crops, however, offers a viable long-term solution. Both rural communities and sophisticated suburbs can benefit from the immediate availability of biofuels. Biofuels offers the reliable delivery and consumption of energy, employment creation and revenue generation. Furthermore, net ecological gains can be made with the potential to sequester carbon, restore degraded soils, and re-establish native crops that enable the prudent management of the Caribbean ecosystem.

The short-term outlook for biofuels production and use in the Caribbean is otherwise positive. Given the complexity and cost of industrializing the sugar industry, these nations should first focus on mandating domestic energy requirements, such as fuel blending or cogeneration, before developing an export industry. Not only would this rationalize the failing sugar industries and minimize debt, but it would also more quantifiably reduce foreign energy dependencies and enable rural development. Neighboring states could also collaborate research

and capital towards building a joint biofuels industry, particularly given the high costs of building or updating refineries and mills.

Lastly, industrialized nations have legislated energy quotas to meet. Caribbean nations should solicit more public funding from these nations hoping to capitalize on Caribbean energy. Additional funds would not only enable development, research and infrastructure, but also help mitigate the risks of their endeavors. Furthermore, Caribbean nations should ensure that the CBI remains valid in the future because it alone may be the competitive advantage needed to ensure energy security in the Caribbean.

Attachment 2

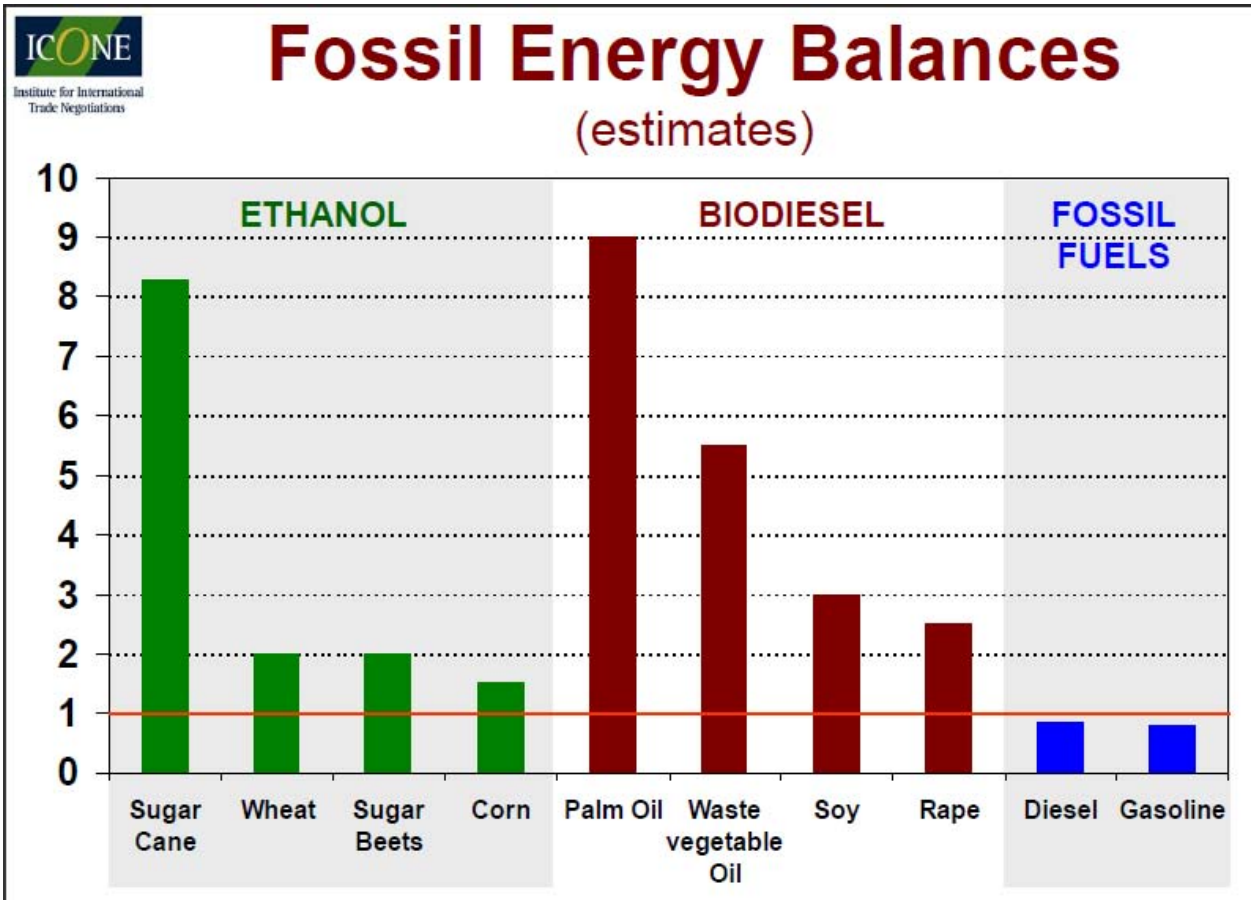
Attachment 3

		ACP-EU Sugar Protocol		U.S. Sugar		total	total
		Quota	Delivery	Quota	Delivery	production	exports
Barbados	2008	eliminated					
	2007	eliminated		8,972	0		
	2006		33,916	8,139	0	32,320	32,168
	2005		35,872			40,000	35,872
Dominican Republic	2008	eliminated				515,000	222,000
	2007	eliminated		225,573	36,799	505,000	198,000
	2006			252,935	252,935	486,860	252,935
	2005					475,000	177,954
Haiti	2008	eliminated					
	2007	eliminated		7,258	0		
	2006		0	7,258	0		0
	2005		0		0		0
Jamaica	2008	eliminated					
	2007	eliminated		14,098	6,216	108,500	
	2006		142,490	19,764	5,193	143,806	140,178
	2005		127,129			126,071	118,905

Source: European Commission, International Sugar Organization, and USDA

Note: EU quotas are given in metric tons of white sugar equivalent and U.S. quotas are in metric tons of raw sugar. The standard conversion of raw cane sugar to refined white sugar is 1.087 units of raw cane sugar required to produce 1.0 unit of white sugar.

Attachment 4



Note: Figures represent the amount of energy contained in the listed fuel per unit of fossil fuel input.

Source: Various, compiled by the World Watch Institute[91]

Attachment 5

Barbados' Medium-Term Strategic and Macroeconomic Framework (2003):[92]

(i) Transformation of the sugar industry to take advantage of value added activities in pharmaceuticals, energy, alcohol, rum, board, wax and sweeteners

(ii) Continue research between Ministry of Agriculture and Michigan State University on alternative uses for sugarcane

(iii) Introduction of cane separation technology for alternative uses of cane juice

(iv) Continue to meet EU obligations and that of the domestic market by producing 40,000 tonnes of sugar annually

(v) Maintain technological and fiscal support to the industry as well as annual assistance to BAMC in 'out-of-crop' financing

(vi) Introduce sugarcane replanting incentive scheme to encourage producers to maintain and return lands to cane cultivation

(vii) Price support to the independent plantations as an incentive to continue Production

(viii) Continue government support to meet part of the wage bill of independent growers as well as meeting the cost of new diversification activities.

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